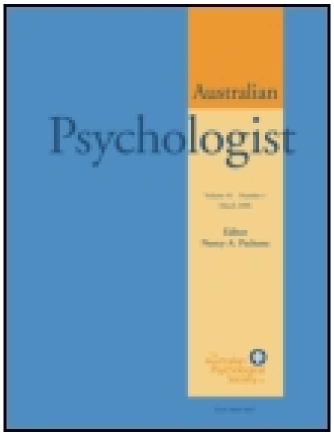

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Influence of language background on tests of cognitive abilities: Australian data

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Abstract

This study examines the effect of language background on the performance of healthy participants on a battery of cognitive measures. The study was conducted as part of a larger normative study: the Macquarie University Neuropsychological Normative Study (MUNNS). A comparison was made between the test performance of three language background groups: participants from a non-English-speaking background whose first language was other than English (NESB-OE, $N = 42$); participants from a non-English-speaking background whose first language was English (NESB-E, $N = 34$); and participants from an English-speaking background (ESB, $N = 40$). A number of tests used in clinical neuropsychological assessment were found to be sensitive to the background of the participant, and trends in the data suggest that two factors are operating independently. It is proposed that one factor is language or proficiency in English that impacts on verbal subtests and the other is a sociocultural factor that impacts on performance or nonverbal subtests. These findings question current practices when assessing people from non-English-speaking backgrounds.

Subgroup differences in performance on cognitive tests have been extensively documented in the literature for many years (see Neisser et al., 1996, for a summary). Much of the research relevant to this area has been conducted in the United States but there is a growing international database on the topic, generally supportive of the U.S. findings (Baron, Martin, Proud, Weston, & Elshaw, 2003). The presence of these differences has proven to be a bane to both theorists and practitioners alike. Individual differences theorists have failed to provide an adequate explanation for the occurrence of subgroup differences and nature/nurture considerations in this area continue to generate heated debate (Fraser, 1995). In spite of this, cognitive test performance has proven to be extremely useful and predictive in many areas of applied psychology, from the diagnosis of cognitive deficits in clinical neuropsychology to personnel selection in organisational psychology. Practitioners working in these fields must have some way of taking subgroup differences into account in any practical application of test scores in a multicultural society such as Australia. Pragmatic solutions may be necessary until the problem can be solved theoretically.

The purpose of this paper is to document the presence of subgroup differences in cognitive performance using an Australian sample in which the groups are formed in terms of heterogeneous ethnic, racial and linguistic backgrounds. This information makes a contribution in two ways. First, it provides some Australian data on the presence of subgroup differences. There appears to be a gap in the literature in this regard given that a recent international review of the topic contained no mention of Australia (Baron et al., 2003). Second, it will alert Australian practitioners to the fact that international concerns about subgroup differences apply to them with equal force. Anecdotal evidence suggests that this issue has not been a priority among many Australian practitioners in spite of the multicultural nature of Australian society.

Ongoing migration to Australia from a large number of countries has meant that Australia is populated by people from numerous cultural and language backgrounds. For example, according to the 1991 and

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1996 Census, 25% of Australians were of non-English-speaking origin. The 2001 Census, which recorded a slightly different set of demographics, found that 22% were born overseas and 14% speak one of more than 30 languages other than English at home. Most recent reports indicate that one quarter of all Australians was born overseas (Australian Bureau of Statistics, 2005). The Australian Bureau of Statistics has grappled with the problem of defining and measuring cultural and language diversity and has concluded that no simple definition is possible (Australian Bureau of Statistics, 1999) and that a minimum core set of four variables is required to capture the concept. These indicators include country of birth, main language other than English spoken at home, self-reported proficiency in spoken English and indigenous status. However, there is no simple way of combining these indicators without arriving at groupings of individuals that are necessarily heterogeneous. As reported below, the present study has attempted to group individuals in a meaningful way for the Australian context, and to allow comparisons between groups that reflect distinct differences in language and cultural background.

Macquarie University Neuropsychological Normative Study

Data reported in the current study come from the Macquarie University Neuropsychological Normative Study (MUNNS), which was conducted to establish normative data for neuropsychological measures commonly used in the rehabilitation and medico-legal assessment of patients with traumatic brain injury. Participants comprised a representative sample of healthy young Sydney adults, and the resultant normative data have provided local standards against which brain-injured patients can be compared (e.g., Bowden, Carstairs, & Shores, 1999; Shores & Carstairs, 2000).

A major impetus for the study came from research findings from the three comprehensive nervous system injury trauma centers in the United States that strongly emphasised the importance of using local control groups in neuropsychological research (Levin et al., 1987). That investigation highlighted the immense contribution of sociocultural factors to neurobehavioural performance despite the similar periods of education reported by the research participants in the three centres.

In the Australian context, the association between neuropsychological test scores and extent of underlying brain damage is estimated mainly by reference to U.S. normative samples that reflect distinctly different demographic characteristics from the Australian population, particularly with respect to the representation of people having non-English-speaking origins. Furthermore, the issue of comparing the performance of non-English speakers with normative data obtained from English-speaking mainstream populations has recently been addressed by Artiola i Fortuny and Mullaney (1998), who strongly suggested that people who do not speak English should not be tested on current tests even with the use of an interpreter. This raises the question of the appropriateness of using current tests on people who can speak English but who come from a non-English-speaking background.

The MUNNS sample was selected to be representative of the Sydney metropolitan population in terms of age, gender, education, socioeconomic status and language background (see Carstairs & Shores, 2000, for details of the MUNNS methodology and sample characteristics). Because approximately one quarter of the Australian population consists of people having non-English-speaking origins, the study provided the opportunity to investigate the effect of language background on the performance of cognitive tests.

Method

Participants

The MUNNS normative sample consisted of 399 randomly selected healthy adults living in the Sydney metropolitan area. There were 193 men and 206 women aged between 18 and 34 years ($M = 25.6$, $SD = 5.0$). Language background was categorised as either English speaking (ESB), comprising 72% of the sample, or non-English speaking (NESB), the remaining 28% of the sample. An individual was defined as having non-English-speaking origins if either of his or her parents was born overseas and first spoke a language other than English. An inclusion criterion for the MUNNS normative sample was that participants could speak and read English. Therefore all participants from a non-English-speaking background could speak English and reported that they were proficient at reading English.

For the purpose of the present analysis, NESB participants were further categorised as those who first spoke a language other than English as a child (NESB-OE, $N = 42$) and those who first spoke English as a child (NESB-E, $N = 34$). Table 1 shows the parents' country of origin for each group. The parents of NESB-OE participants came from 30 different countries whereas the parents of NESB-E participants came from only 15, reflecting changing patterns of migration to Australia: in general, the families of NESB-OE participants migrated to Australia more recently than the families of NESB-E participants.

In order to compare the test performance of the three groups, we randomly selected 40 ESB

Table 1. Country of origin of one or both parents of NESB participants

Parents' country of origin	NESB-OE ($N = 42$)		NESB-E ($N = 34$)	
	n	%	*n*	%
Armenia	1	2.4		
Bangladesh	1	2.4		
Cambodia	2	4.8		
Canada	1	2.4		
China	5	11.9		
Croatia	2	4.8		
Cyprus	1	2.4		
Czechoslovakia	1	2.4		
Denmark	1	2.4	1	2.9
Egypt			4	11.8
Fiji	2	4.8		
Germany	2	4.8	2	5.9
Greece	1	2.4	4	11.8
Holland	1	2.4	4	11.8
Hungary	1	2.4	1	2.9
Iran	1	2.4		
Iraq	1	2.4		
Israel			1	2.9
Italy	1	2.4	6	17.6
Jordan	1	2.4	1	2.9
Laos	1	2.4		
Lebanon	3	7.1	3	8.8
Malta			3	8.8
Malaysia	1	2.4	1	2.9
Morocco	1	2.4		
Palestine			1	2.9
Philippines	2	4.8		
Poland	1	2.4		
Romania	1	2.4		
Samoa	1	2.4		
Singapore			1	2.9
Somalia	1	2.4		
Sweden			1	2.9
Taiwan	2	4.8		
Vietnam	1	2.4		
Yugoslavia	1	2.4		

Note. NESB = non-English-speaking background; NESB-E = non-English-speaking background with English as first language; NESB-OE = non-English-speaking background and first language other than English.

participants to represent participants of English-speaking origins. This was done to balance the *N*s in the analysis. There were no significant differences between NESB-OE, NESB-E and ESB groups in terms of gender composition, NESB-OE = 52% male; NESB-E = 62% male; ESB = 40% male; $\chi^2(2) = 3.54$, $p = 0.170$; age in years, NESB-OE: $M = 25.2$, $SD = 4.9$; NESB-E: $M = 25.4$, $SD = 5.4$; ESB: $M = 25.3$, $SD = 5.3$; $F(2,113) = 0.014$, $p = 0.986$; years of education, NESB-OE: M = 13.4, $SD = 1.6$; NESB-E: M = 12.7, $SD = 2.1$; ESB: M = 13.0, $SD = 2.5$; $F(2,113) = 1.218$, $p = 0.300$; or highest education qualification achieved, NESB-OE = 21.4% degree or graduate diploma, 40.5% partly completed degree, 21.4% completed or partly completed technical or college certificate, 9.5% Year 12 or equivalent, 7.1% Year 11 and below; NESB-E = 11.8% degree or graduate diploma, 26.5% partly completed degree, 29.4% completed or partly completed technical or college certificate, 17.6% Year 12 or equivalent, 14.7% Year 11 and below; ESB = 25.0% degree or graduate diploma, 22.5% partly completed degree, 20.0% completed or partly completed technical or college certificate, 12.5% Year 12 or equivalent, 20.0% Year 11 and below; $\chi^2(8) = 8.37$, $p = 0.398$.

Measures

The following tests were administered as part of the MUNNS: Wechsler Memory Scale – Revised (WMS-R; Wechsler, 1987); Rey Auditory Verbal Learning Test (RAVLT; Lezak, 1996), providing an indication of efficiency of verbal learning by calculating total raw scores over Trials 1 – 5; Wechsler Adult Intelligence Scale – Revised (WAIS-R, Wechsler, 1981); Stockings of Cambridge Test (previously the Tower of London Test) from the Cambridge Neuropsychological Test Automated Battery (Cambridge Cognition, 1995), a nonverbal test of spatial planning and executive functioning; Category Test (Computerised version, Choca, Laatsch, Garside, & Arnemann, 1994), a nonverbal test of executive functioning providing a measure of fluid intelligence; Excluded Letter Fluency Test (Crawford, Wright, & Bate, 1995), a verbal test of information processing; Speed and Capacity of Language Processing Test Form A (SCOLP; Baddeley, Emslie, & Smith, 1992); a contextual version of the Australian National Adult Reading Test (C-AUSNART) (Hennesy, 1995); and the Depression, Anxiety and Stress Scales (DASS; Lovibond & Lovibond, 1995).

Procedure

Tests were administered in the order outlined above. Full details of the procedure can be found in Carstairs and Shores (2000). The C-AUSNART was introduced part way through the study and consequently data are available for only a subset of participants.

Results

For the WMS-R and WAIS-R, raw scores were converted to MUNNS demographically adjusted scaled scores, which correct for differences in education, age and sex. WMS-R Indexes and WAIS-R IQ scores were based on Australian norms (Shores & Carstairs, 2000). All other test results are reported as raw scores or summary scores of raw scores.

The effects of language background on test performance were assessed using analysis of variance (ANOVA) followed by Scheffé's method of multiple comparisons. To minimise the possibility of Type I errors over a series of several analyses, an alpha rate of 0.01 was adopted and the results are presented in Tables 2 and 3. Table 2 shows mean test performance for NESB-OE, NESB-E and ESB groups on those tests for which no statistically significant differences were evident and Table 3 shows mean test performance on those measures for which significant differences were found.

Table 2 shows that all language groups scored similarly on the Depression, Anxiety and Stress scales of the DASS, suggesting that any differential test performance is unlikely to be a result of group differences in emotional wellbeing. Table 2 also indicates that language background does not impact on learning and memory functioning as assessed by the WMS-R and the RAVLT. Further, language background does not influence performance on the Stockings of Cambridge (CANTAB), Category Test or Excluded Letter Test, all tests of verbal and nonverbal higher order or executive functioning.

Table 3 presents means and standard deviations for those tests and subtests for which a significant group effect was evident. MUNNS-corrected verbal IQ (VIQ), performance IQ (PIQ) and full scale IQ (FSIQ) scores were all found to be susceptible to language background. NESB-OE participants were found to have VIQ scores significantly below those of the NESB-E and ESB groups, this difference amounting to approximately 10 IQ points. Differences in VIQ can primarily be attributed to differences on the Vocabulary subtest. Although this is the only WAIS-R verbal subtest to show a significant group effect (Table 3), a similar trend is evident in other verbal subtests. Mean performance of the NESB-OE group was below that of NESB-E and ESB groups, suggesting that NESB-OE participants were disadvantaged due to their lack of proficiency with the English language rather than due to cultural differences. A mean difference of 10 IQ points was also evident for MUNNS-corrected PIQ scores, but in this instance it was both

Table 2. Tests showing no effect of language background (*M*, *SD*)

	Language group			ANOVA	
Test	NESB-OE	NESB-E	ESB	*F*	*P*
WMS-R	*N* = 42	*N* = 34	*N* = 40		
MUNNS-corrected Verbal Memory Index	97.05 (14.55)	98.35 (15.01)	102.43 (14.82)	1.45	.238
MUNNS-corrected Visual Memory Index	96.93 (14.00)	94.97 (13.62)	102.73 (14.90)	3.07	.050
MUNNS-corrected General Memory Index	96.40 (13.61)	95.65 (13.20)	103.03 (14.55)	3.35	.039
MUNNS-corrected Attention/Concentration Index	94.81 (11.37)	100.12 (17.82)	102.78 (14.54)	3.17	.046
MUNNS-corrected Delayed Recall Index	98.26 (14.45)	97.94 (16.68)	101.58 (12.01)	.762	.469
Stockings of Cambridge (CANTAB)	*N* = 42	*N* = 33	*N* = 40		
Initial Thinking Time, 5-move problem (ms)	11093 (8756)	12290 (7921)	12424 (7465)	.338	.714
Subsequent Thinking Time, 5-move problem (ms)	1902 (2575)	1445 (1504)	1410 (1483)	.789	.457
Category Test	*N* = 42	*N* = 33	*N* = 40		
Predicted final error score	57.95 (30.88)	51.36 (25.64)	44.63 (20.50)	2.663	.074
Excluded Letter Fluency Test	*N* = 42	*N* = 34	*N* = 40		
Total Correct	46.19 (13.68)	49.21 (10.86)	51.90 (16.05)	1.750	.179
Rey Auditory Verbal learning Test	*N* = 41	*N* = 34	*N* = 40		
Trials 1 – 5 Total Raw Scores	57.32 (7.71)	53.12 (7.79)	57.70 (7.7)	3.884	.023
DASS	*N* = 41	*N* = 34	*N* = 40		
Depression	4.73 (5.81)	4.97 (6.29)	5.15 (5.22)	.054	.948
Anxiety	4.85 (4.44)	3.88 (3.67)	3.90 (4.09)	.726	.486
Stress	8.22 (6.16)	9.71 (6.59)	10.48 (6.06)	1.357	.262

Note. DASS = depression, anxiety and stress scales; ESB = English-speaking background; MUNNS = Macquarie University Neuropsychological Normative Study; NESB-E = non-English-speaking background with English as first language; NESB-OE = non-English-speaking background and first language other than English; WMS-R = Wechsler Memory Scale – Revised.

Table 3. Tests showing significant effects of language background (*M*, *SD*)

	Language Group			ANOVA	
Test	NESB-OE	NESB-E	ESB	*F*	*P*
WAIS-R	*N* = 42	*N* = 34	*N* = 40		
MUNNS-corrected VIQ	90.14[ab] (14.85)	99.32 (12.70)	100.78 (14.54)	6.748	.002
Information (scaled scores)	8.29 (3.06)	9.85 (2.84)	9.90 (2.57)	4.229	.017
Digit Span (scaled scores)	8.86 (2.29)	10.41 (3.34)	9.98 (2.97)	3.048	.051
Vocabulary (scaled scores)	7.45[ab] (3.13)	9.88 (2.45)	10.10 (2.43)	11.904	.001
Arithmetic (scaled scores)	9.07 (2.83)	9.97 (2.44)	10.30 (3.26)	1.988	.142
Comprehension (scaled scores)	8.88 (3.19)	9.88 (2.53)	10.63 (2.89)	3.726	.027
Similarities (scaled scores)	8.98 (3.13)	9.71 (2.98)	10.10 (2.56)	1.587	.209
MUNNS-corrected PIQ	93.19[a] (17.73)	93.53[c] (12.79)	103.95 (14.28)	6.356	.002
Picture Completion (scaled scores)	8.60[a] (3.08)	8.00[c] (2.57)	11.45 (2.92)	15.744	.001
Picture Arrangement (scaled scores)	9.83 (2.80)	9.62 (3.13)	10.58 (2.82)	1.140	.323
Block Design (scaled scores)	8.67 (3.21)	9.21 (2.48)	10.38 (2.91)	3.648	.029
Object Assembly (scaled scores)	8.55 (3.19)	9.00 (2.75)	10.23 (2.63)	3.668	.029
Digit Symbol (scaled scores)	9.50 (3.17)	10.09 (2.39)	10.00 (2.54)	.529	.591
MUNNS-corrected FSIQ	90.40[a] (15.21)	96.35 (13.20)	102.58 (14.65)	7.263	.001
SCOLP	*N* = 42	*N* = 34	*N* = 40		
Speed of Comprehension	44.76[ab] (19.83)	57.56 (15.26)	63.63 (16.63)	12.414	.001
Spot the Word	42.33[ab] (6.96)	46.62 (4.49)	47.93 (4.92)	10.992	.001
C-AUSNART	*N* = 29	*N* = 27	*N* = 19		
Mean Errors	36.19[a] (12.51)	28.03 (10.65)	24.21 (11.59)	6.639	.002

Notes. C-AUSNART = contextual Australian national adult reading test; ESB = English-speaking background; FSIQ = full scale IQ; MUNNS = Macquarie University Neuropsychological Normative Study; NESB-E = non-English-speaking background with English as first language; NESB-OE = non-English-speaking background and first language other than English; PIQ = performance IQ; SCOLP = Speed and Capacity of Language Processing Test Form A; VIQ = verbal IQ; WAIS-R = Wechsler Adult Intelligence Scale – Revised.
[a]NESB-OE group significantly different from ESB group.
[b]NESB-OE group significantly different from NESB-E group.
[c]NESB-E group significantly different from ESB group.

NESB-OE and NESB-E groups that performed significantly below the level of the ESB group. The subtest contributing to this difference was Picture Completion, where NESB-OE and NESB-E groups performed significantly below that of the ESB group. Again, other WAIS-R performance subtests reflected this trend. These findings suggest that cultural differences, rather than language proficiency, influence PIQ. Differences in FSIQ reflect the combined differences outlined above, with NESB-OE participants having a statistically significant mean difference of 12 IQ points below ESB participants. NESB-E participants had a mean FSIQ approximately 6 points above NESB-OE participants, and 6 points below ESB participants, although these differences were not significant.

The influence of language background is further evident from performance on the SCOLP, a measure designed to assess language processing. NESB-OE participants perform at a significantly lower level than either NESB-E or ESB participants, suggesting a disadvantage resulting from a lack of proficiency in English. These findings were similar for both the Speed of Comprehension and Spot the Word subtests. The results for the C-AUSNART indicated that NESB-OE participants have significantly greater mean errors than ESB participants, while NESB-E participants do not differ significantly from either of the other two groups, although their performance is closer to that of ESB participants than NESB-OE participants.

Discussion

The above findings suggest that people from a non-English-speaking background who first spoke a language other than English are disadvantaged on verbal subtests due to a lack of proficiency in English. Further, people from a non-English speaking background tend to show a disadvantage on some performance or nonverbal tests irrespective of which language they first spoke. This suggests that two factors are operating independently: one is language or proficiency in English, which impacts on the verbal subtests, and the other might be considered a sociocultural factor, which impacts on performance of nonverbal subtests. Cultural differences have not been directly assessed in this study, and there is a need to explore this interpretation more fully through further research. However, the proposition that observed group differences can be ascribed to either differences in

proficiency in English or sociocultural differences, is strengthened if we can dismiss other possible explanations.

In the present study, group differences in test performance cannot be explained by demographic differences in gender composition, age, years of education or highest educational qualifications because these variables were found not to differ across the three language background groups. In addition, for the WAIS-R and WMS-R, MUNNS norms are adjusted to take into account the effects of these demographic variables at the individual level. As a further check, the above analyses were repeated using number of years of education and highest level of education attained as covariates, and the results remained unchanged. It is also unlikely that differences in emotional wellbeing account for differences in test performance because DASS results showed no differences between groups.

An alternative explanation for the current findings is that differences in test performance are a true reflection of differences in cognitive ability. That is, that the 12-point difference in FSIQ between NESB-OE and ESB participants is a true reflection of their cognitive ability and is not due to differences in language proficiency or sociocultural background. The evidence against this latter interpretation is two-fold. First, there were no group differences in performance on the Category Test, which is the most pure measure of fluid intelligence in the MUNNS test battery (Choca, Laatch, Wetzel, & Agresti, 1993). Second, there were no group differences in performance on the Stockings of Cambridge (CANTAB), which is a nonverbal test that may be considered to be resilient to the effects of language background (Owen, Downes, Sahakian, Polkey, & Robbins, 1996). The most compelling evidence for the independent operation of two factors comes from the WAIS-R data, which suggest the impact of English proficiency on VIQ and the impact of cultural differences on PIQ.

As discussed previously, a limitation of this study is that there was no independent assessment made of language or cultural factors. In addition the sample sizes are small, especially for the C-AUSNART, which was added to the MUNNS test battery part way through the study. However, despite the relatively modest sample sizes, the reported effects are robust. The results from this study support the views of Levin et al. (1987) that sociocultural factors impact on test performance.

The focus of the MUNNS study was not on language or cultural issues. However, 28% of the participants were from non-English-speaking backgrounds, reflecting Australia's cultural heterogeneity and giving us the opportunity to explore the issue of sociocultural influence on test performance. The present analysis has highlighted the importance of these characteristics and care needs to be taken when testing people from non-English-speaking backgrounds. In addition, a distinction should be made between those individuals who first spoke a language other than English and those who first spoke English, because this might determine the extent of any disadvantage they may experience on a particular test. These findings have important implications for clinical practice because current practice assumes that using nonverbal tests reduces the influence of coming from a non-English-speaking background. However, the results of this study challenge this view and emphasise a need for caution in the interpretation of test results, and the need for further research in this area to ensure the availability of appropriate normative data.

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